Available online at www.sciencedirect.com
ScienceDirect
Procedia - Social and Behavioral Sciences 216 (2016) 622 – 631
Procedia Social and Behavioral Sciences

Urban Planning and Architecture Design for Sustainable Development, UPADSD 14- 16 October 2015

The Relationship between Respiratory Systems' Cases and Environmental Urban Factors

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Abstract

Air pollution in urban areas which have dense population, industrial facilities and dependence on the private automobiles, adversely affects the number of respiratory system diseases. The aim of the study is to test the relation between the number of respiratory systems cases' and environmental urban factors affecting these cases such as the level of urban air pollution, current land use, total population and the number of vehicles. The data are collected for six districts in Izmir, Turkey for the years between 2007 and 2011. The results show that there's a statistically significant relationship between the number of respiratory systems' cases and environmental urban factors.

Peer-review under responsibility of IEREK, International experts for Research Enrichment and Knowledge Exchange

Keywords: Urban air pollution; respiatory system disease; urban planning; public health; Izmir

1. Introduction

Urban planning and public health share common missions and perspectives; because of this, environment is quite important for human health. Both of them aim to improve human well-being, emphasize needs assessment and service delivery, manage complex social systems, focus at the population level and rely on community-based participatory methods; also focus on the needs of vulnerable populations in urban area. Throughout their development, both fields have broadened their perspectives.

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1877-0428
Peer-review under responsibility of IEREK, International experts for Research Enrichment and Knowledge Exchange
doi:10.1016/j.sbspro.2015.12.040

Urban planning professionals deal with the public health arena, participating in campaigns promoting physical activity and pedestrian injury prevention and serving on boards of health, and incorporating design into public health decision-making. Coordinated policies and actions are needed to address the underlying conditions of major health issues in cities today. Environmental health studies are related to the effects of environmental factors, such as air pollution and the effective health policies. It is well-known as a fact that air pollution is one of the causes of respiratory diseases (lung cancer, asthma, chronic obstructive pulmonary etc.).

Public health explicitly recognizing the importance of place-based approaches and the leverage these provide for addressing public health opportunities and threats. Public health and urban planning professionals increasingly drawing on tools and processes developed by the other fields such as geographic information systems (GIS); health impact assessment; and community assessment tools. Public health professionals deal with the urban planning arena and incorporating health into urban planning decision-making.

The “health” concept in urban planning arena is more appropriate for planning activities within the frame of sustainable development; hence the target of a healthy city is related with a healthy economy, environment and society. In the process of developing a healthy city, all related actors (such as central and local governments, private sector, non-governmental organizations, and citizens) are expected to be in continuous collaboration. Actually, sustainable development and healthy city concept take into consideration social, environmental, economic and cultural issues and how these affects individuals, communities and populations’ lives (Basaran, 2007; Santos et al., 2012).

World Health Organization (WHO) defines the features that a “healthy city” concept should have as a sustainable ecosystem, quality and safe physical environments, a society with provided basic needs and participated in decisions about the future of the city, innovative economy, optimum access to the goods and services, an environment that cultural and historical assets are protected in, high level statute of health, low level incidence of a disease (Santos et al., 2012). The World Health Organization Regional Office for Europe (WHO / EURO) has been working to achieve the implementation of "Health for All" within the "Healthy Cities Project" at the local level (Basaran, 2007; Santos et al., 2012).

From this point of view, the aim of the study is to test the relation between the number of respiratory systems cases’ and environmental urban factors affecting these cases such as the level of urban air pollution (the particulate matter (PM_{10}) and sulfur dioxide (SO_2)), current land use, total population and the number of vehicles. The data are collected for six districts in Izmir, Turkey including Konak, Bornova, Buca, Karsiyaka, Cigli and Balcova for the years between 2007 and 2011. The results show that there is a statistically significant relationship between the number of respiratory systems’ cases and environmental urban factors.

2. Literature

Air pollution in urban areas which have dense population, industrial facilities and dependence on the private automobiles, adversely affects the incidence rate of respiratory system related diseases (lung cancer, chronic obstructive pulmonary disease (COPD), upper respiratory tract infections, asthma, bronchitis, etc.).

In literature, there exist a lot of studies about air quality and respiratory system related diseases relationship either positive or negative influence. These studies are differentiated in terms of the type of disease. Generally, respiratory system related diseases studies are performed by (Schikowski et al., 2005; Tagil and Mentese, 2012; Cengiz et el., 2013; Unsal et al., 1999; Zhang et al., 2013; Darcin, 2013; Jerrett et al., 2009; Dockery & Schwartz, 1993 and Wong et al., 2011).

Recent researches by (Gehring et al., 2010; Mallant et al., 2010) provide further evidence that traffic-related air pollution exposure may contribute to the development of asthma in children, and not only aggravates existing symptoms. Some cross-sectional studies in Europe have shown that deficits in lung function growth in children – associated with morbidity and mortality in adulthood (Brauer et al., 2008; Knuiman et al., 1996) are related to residential exposure to high traffic (Brunekreef et al., 1997; Gauderman et al., 2007).

The air pollutants causing decrease in air quality and increase public health problems in urban area vary depending on the contaminant source, meteorological and topographical conditions and land use. Especially, the particulate matter in the atmosphere (TAP, $PM_{2.5}$, PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3) and carbon monoxide (CO) lead to increase in the level of air pollutants; because of the less activity in urban study areas located in urban centers, increasing traffic congestion and population density in time by (Incecik, 1994; Bayram, 2008; Colls, 2002 and Fenger, 2002).

There exist studies in literature about the relationship between the level of air quality and just one pollutant. These studies are classified as the level of particulate matter (TAP) by (Chen et al., 2000; Zanobetti et al., 2000; Sheppard et al., 1999; Dockery et al., 1993 and Celikoglu, 1999) and SO_2 based study by (Unsal et al., 1999).

Besides, there exist studies with more than one pollutant and respiratory system related diseases relationship; for example by (Koc et al., 2002; Tagil & Mentese, 2012 and Cengiz et el., 2013) performed the particulate matter (TAP, PM2.5, PM10) and the other pollutants; Zhang et al. (2013) realized SO2 and the other pollutants; Jerrett et al. (2009) and Koc et al. (2002) examined NO_2 and the other pollutants; Wong et al. (2011), Schwartz (1994), Tao et al. (2011) and Samet et al. (2000) did O_3 and the other pollutants.

3. Data and Study Area

The study area has six districts of Izmir City Center: Konak, Bornova, Buca, Karsiyaka, Cigli and Balcova. There are totally 2.461,180 respiratory systems' cases and 6992 lung cancer cases between 2007 and 2011. In 2009, Konak district has been divided as Konak and Karabaglar. Also Karsiyaka district has been divided as Karsiyaka and Bayrakli. Respiratory systems' cases and lung cancer cases have been recorded in the districts of Konak and Karsiyaka until 2009, and have been started being recorded in the districts of Konak, Karabaglar, Bayrakli and Karsiyaka. In this study, for 2009 and 2010 respiratory systems' cases and lung cancer cases, Karabaglar cases have been counted in Konak district and also Bayrakli cases have been counted in Karsiyaka district.

The data for the number of respiratory systems' cases and lung cancer cases are obtained from the Statistics Unit in Public Health Directorate of Ministry of Health. The study area is represented in Figure 1, the descriptive statistics for the number of respiratory systems' cases between 2007 and 2011 at district level is shown in Table 1 and the spatial distribution of them presented in Figure 2. The descriptive statistics for the number of lung cancer cases between 2007 and 2011 at district level is shown in Table 2 and the spatial distribution of them presented in Figure 3. Data for the level of air quality at the daily basis are available from Environmental Health Unit of Izmir Metropolitan Municipality. The descriptive statistics at the district level as annual averages for PM_{10} and SO_2 are presented in Table 3 and Table 4. Finally, the descriptive statistics for total population at the district level are shown in Table 5, the descriptive statistics for total vehicles at the district level are shown in Table 6 and the descriptive statistics for the size of current land use (hectares) at the district level are shown in Table 7. The data for land use presents the current size of the year 2011, because there has been no remarkable change in land use pattern and size between 2007 and 2011. Thus, there are 30 observations in the data set.

Fig. 1. The Study Area (Turkey, Izmir, Districts of Study Area) (Google Earth, 2015)

Table 1. The descriptive statistics of the annual respiratory systems' cases at the district level (2007-2011) (n=30)

Year	Minimum	Maximum	Mean	Std. Deviation
2007	14788	152634	85140,00	52930,448
2008	22597	191137	101901,00	65229,814
2009	27564	241743	123531,83	82071,339
2010	21248	169501	99523,17	58990,318
2011	0	468	100,67	187,855

Table 2. The descriptive statistics of the annual lung cancer cases at the district level (2007-2011) (n=30)

Year	Minimum	Maximum	Mean	Std. Deviation
2007	61	594	234,33	196,153
2008	46	554	242,67	184,223
2009	48	579	236,00	192,491
2010	46	549	233,83	182,118
2011	56	504	218,50	162,981

Table 3. The descriptive statistics of the annual average daily PM_{10} ($\mu g/m^3$) levels at the district level (2007-2011) (n=30)

Year	Minimum	Maximum	Mean	Std. Deviation
2007	0	72	44,83	27,549
2008	5	29	16,83	9,283
2009	0	76	45,83	25,341
2010	36	51	45,67	6,055
2011	37	71	54,83	13,805

Table 4. The descriptive statistics of the annual average daily SO_2 ($\mu g/m^3$) levels at the district level (2007-2011) (n=30)

Year	Minimum	Maximum	Mean	Std. Deviation
2007	0	33	11,50	12,645
2008	2	41	16,83	14,770
2009	10	26	14,00	6,132
2010	6	16	12,50	3,619
2011	5	29	16,83	9,283

Table 5. The descriptive statistics of total population at the district level (2007-2011) (n=30)

Year	Minimum	Maximum	Mean	Std. Deviation
2007	74837	847409	408238,67	278943,148
2008	76219	853449	413306,33	286371,850
2009	77915	859958	419668,17	289080,557
2010	77767	863579	424754,50	290442,271
2011	77941	859563	425837,33	286834,838

Table 6. The descriptive statistics of the number of vehicles at the district level (2007-2011) (n=30)

Year	Minimum	Maximum	Mean	Std. Deviation
2007	154025	1744086	838032,17	575140,222
2008	161061	1803448	873369,83	605140,711
2009	165136	1822628	889460,83	612688,472
2010	167218	1856910	913329,67	624521,309
2011	176797	1949800	970781,50	654430,454

Table 7. The descriptive statistics of the size of current land use (hectares) at the district level (2011)

Year	Minimum	Maximum	Mean	Std. Deviation
Open and Green Areas	35	305	165,70	90,289
Industrial Areas	0	684	249,07	326,711
Residential Areas	308	3994	2424,98	1296,930

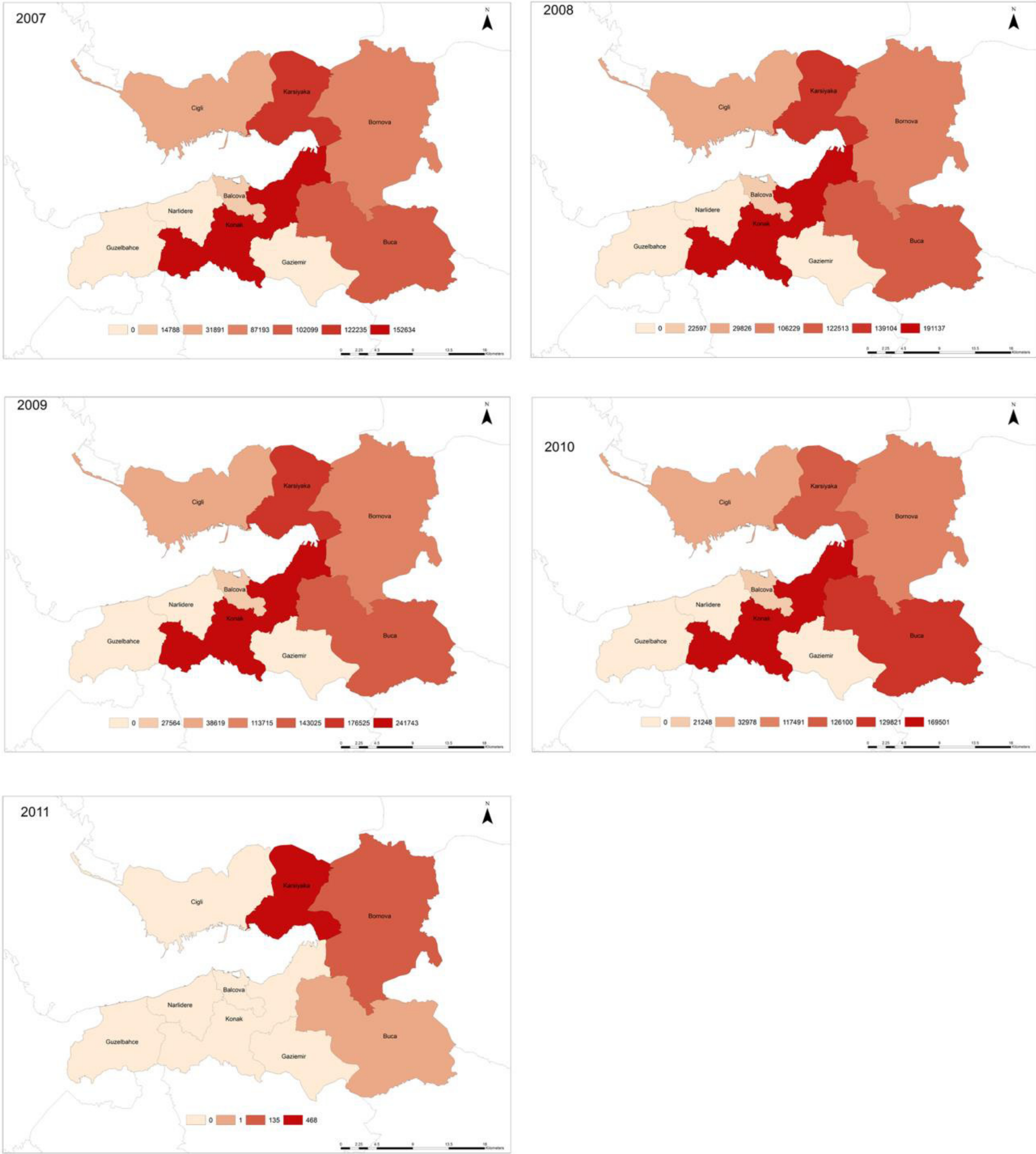

Fig. 2. The spatial distribution of respiratory systems' cases at the district level (2007-2011) (n=30)

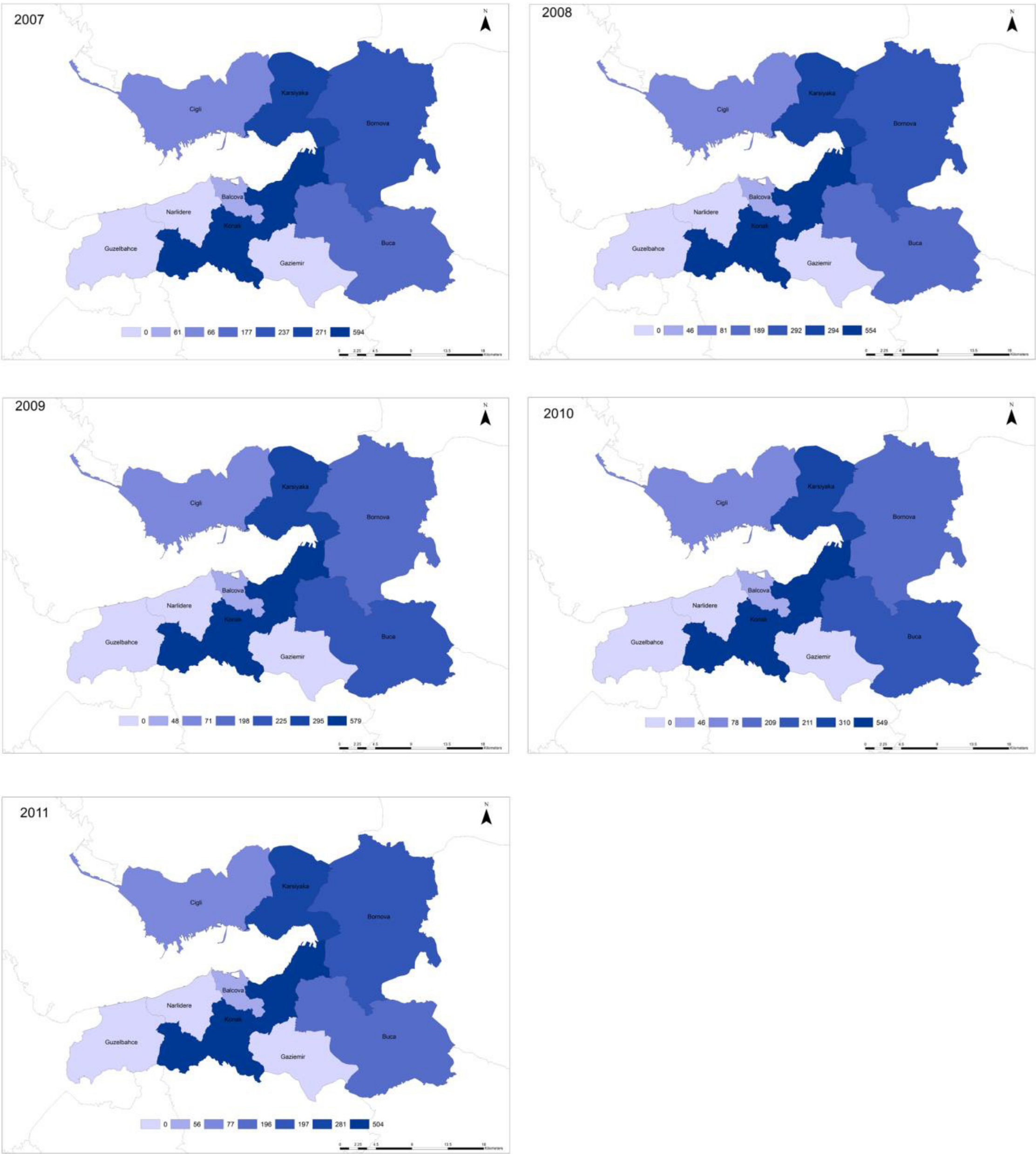

Fig. 3. The spatial distribution of lung cancer cases at the district level (2007-2011) (n=30)

The number of respiratory systems' cases varies between 14,788 and 152,634 people, with a mean of 85,140 people in 2007. As seen in Table 1 and Figure 2, a continuous increase in the numbers of recorded respiratory systems' cases is observed through the years between 2008 and 2010 (Table 1). According to the data taken from the Public Health Directorate within of the Ministry of Health, there is a sharp decrease in the records of respiratory systems' cases in 2011. As seen in Figure 2, this increase in the number of respiratory systems' cases is significant especially in Buca, Karsiyaka, and Konak districts. The number of lung cancer cases varies between 61 and 594 people, with a mean of 234,33 people in 2007. As seen in Table 2 and Figure 3, a continuous decrease in the numbers of recorded lung cancer cases is observed especially in Konak, Karsiyaka, Bornova and Buca districts through the years between 2008 and 2011 (Table 2).

According to the data taken from the Environmental Health Unit of Izmir Metropolitan Municipality, the daily average PM_{10} at the annual basis values vary between 0 $\mu g/m^3$ and 72.0 $\mu g/m^3$, with a mean of 44.83 $\mu g/m^3$ in 2007. An increase in the average PM_{10} level is seen after 2010 (Table 3). The daily average SO_2 values vary between 0 $\mu g/m^3$ and 33.0 $\mu g/m^3$, with a mean of 11.50 $\mu g/m^3$ in 2007. They vary 2.0 $\mu g/m^3$ and 41.0 $\mu g/m^3$ between 2007 and 2011 (Table 4). The total population of the districts varies between 74,837 and 847,409 people, with a mean of 408,238 people in 2007. As seen in Table 5, a continuous increase in the numbers of recorded total population of the districts is observed through the years between 2008 and 2011 (Table 5). The number of vehicles varies between 154,025 and 1.744,086, with a mean of 838,032 vehicles in 2007. As seen in Table 6, a continuous increase in the numbers of recorded vehicles of the districts is observed through the years between 2008 and 2011 (Table 6). The size of open and green areas in the scale of districts varies between 35 ha and 305 ha, with a mean of 165,70 ha in 2011. The size of industrial areas in the scale of districts varies between 0 ha and 684 ha, with a mean of 249,07 ha in 2011. The size of residential areas in the scale of districts varies between 308 ha and 3994 ha, with a mean of 2424,98 ha in 2011 (Table 7).

4. Results of The Statistical Analyses

Multivariate linear regression is used to examine the possible effects of environmental urban factors on the number of respiratory systems' cases and lung cancer cases at the district level in Izmir between the years 2007 and 2011, taking into account the effect of the total population, total vehicles and current land use. The selected model is a no-intercept model. The selected model explains 96% (R^2=0.961) proportion of the variability in the recorded respiratory systems' cases and 99% (R^2=0.994) proportion of the variability in the recorded lung cancer cases. The parameter estimates are presented in Table 8 and 9.

Table 8. Parameter estimates for the selected model (dependent variable: number of respiratory systems' cases in ln form) (n=30)

Variable	Unstandardized Coefficient	Standardized Coefficient	t-statistics	Significance
SO_2	378,424	0,609	3,603	0,019
PM_{10}	443,727	0,194	1,147	0,053
Population	2,617	12,074	4,220	0,000
Vehicle	1,216	12,038	4,507	0,000
Open and Green Areas	86,173	0,149	1,163	0,009
Industrial Areas	45,190	0,164	1,249	0,012
Residential Areas	35,543	0,897	1,776	0,000

The parameter estimates show that the urban air pollutants (the particulate matter (PM_{10}) and sulfur dioxide (SO_2)) increase the recorded number of respiratory systems' cases. The parameter estimates show that the urban air pollutants increase the recorded number of respiratory systems' cases. A one $\mu g/m^3$ increase in the level of sulphur dioxide (SO_2) causes increase in the number of respiratory systems' cases by 378 people. A one $\mu g/m^3$ increase in the level of particulate matter (PM_{10}) causes increase in the number of respiratory systems' cases by 444 people. A one person increase in the total population causes increase in the number of respiratory systems' cases by 3 people. A one vehicle increase in the total vehicle causes increase in the number of respiratory systems' cases by 2 people.

A one hectare increase in open and green areas causes decrease in the number of respiratory systems' cases by 86 people. A one hectare increase in industrial areas causes decrease in the number of respiratory systems' cases by 45 people. A one hectare increase in residential areas causes increase in the number of respiratory systems' cases by 36 people. Among the explanatory variables, the level of sulphur dioxide (SO_2) is statistically significant at the 0.019 level, the level of particulate matter (PM_{10}) is statistically significant at the 0.053 level, the total population, the total vehicle and residential areas are statistically significant at the 0.000 level, the open and green areas is statistically significant at the 0.009 level, industrial areas is statistically significant at the 0.012 level (Table 8).

Table 9. Parameter estimates for the selected model (dependent variable: number of lung cancer cases in ln form) (n=30)

Variable	Unstandardized Coefficient	Standardized Coefficient	t-statistics	Significance
SO_2	49,863	0,396	2,991	0,012
PM_{10}	57,711	0,650	1,610	0,036
Population	177,386	7,837	8,552	0,000
Vehicle	177,200	8,297	8,557	0,000
Open and Green Areas	-144,899	-2,141	-7,513	0,000
Industrial Areas	-78,462	-1,235	-9,251	0,000
Residential Areas	465,255	11,240	10,701	0,000

The parameter estimates show that the urban air pollutants (the particulate matter (PM_{10}) and sulfur dioxide (SO_2)) increase the recorded number of lung cancer cases. A one $\mu g/m^3$ increase in the level of sulphur dioxide (SO_2) causes increase in the number of lung cancer cases by 50 people. A one $\mu g/m^3$ increase in the level of particulate matter (PM_{10}) causes increase in the number of lung cancer cases by 58 people. A one person increase in the total population causes increase in the number of lung cancer cases by 177 people. A one vehicle increase in the total vehicle causes increase in the number of lung cancer cases by 177 people. A one hectare increase in open and green areas causes decrease in the number of lung cancer cases by 145 people. A one hectare increase in industrial areas causes decrease in the number of lung cancer cases by 78 people. A one hectare increase in residential areas causes increase in the number of lung cancer cases by 465 people. Among the explanatory variables, the level of sulphur dioxide (SO_2) is statistically significant at the 0.012 level, the level of particulate matter (PM_{10}) is statistically significant at the 0.036 level; the total population, the total vehicle, the open and green areas, industrial areas and residential areas are statistically significant at the 0.000 level (Table 9).

5. Discussion

In this study, the main aim is to test the relation between the number of respiratory systems' cases and environmental urban factors affecting these cases such as the level of urban air pollution, current land use, total population and the number of vehicles. The data are collected for six districts in Izmir, Turkey including Konak, Bornova, Buca, Karsiyaka, Cigli and Balcova for the years between 2007 and 2011. The results show that there is a statistically significant relationship between the number of respiratory systems cases' and environmental urban factors.

Multivariate linear regression is used to examine the possible effects of environmental urban factors on the number of respiratory systems' cases and lung cancer cases at the district level in Izmir. The statistical analyses are held in two different parameters as the number of respiratory systems' cases and lung cancer cases, because there is a difference in the causing factors of these diseases. In the literature, smoking habit is claimed as the main reason of the lung cancer (Cornfield et al., 2009; Hecht, 2002; Ozlu and Bulbul, 2005) and also the urban air pollution is one of the most important causing factors for the respiratory systems' problems. This paper concerns with the environmental urban factors of the respiratory systems' diseases except smoking habit.

From this point of view, the findings of the analyses show that the increasing rate of total population, motor vehicles, critical changes in the current land use (open and green areas, industrial areas and residential areas) and the decreasing rate of air quality in the study area cause an important increase generally for the number of respiratory systems' cases and lung cancer cases. In Karsiyaka, Konak and Buca Districts, the number of respiratory systems' cases are higher than the other districts. Additionally, in Konak, Karsiyaka, Bornova and Buca Districts, the number of lung cancer cases are higher than the other districts because of the lower air quality, the density of population and motor vehicles in these districts, also having more urban service areas than other districts and the location of these districts according to the main transportation axes.

In metropolitan cities, it is vitally important to minimize the level of air pollutant in the atmosphere for improving quality of life. Recently, several precautions have been introduced for the improvement of urban air quality such as the dissemination of the usage of natural gas for domestic heating, the emission controls for the reduction of the level of air pollutants because of dense motor vehicle in traffic and monitoring of coal sales. Despite these precautions, the level of air pollutants is still above the acceptable level especially during the winter months.

There will be important steps in order to solve air pollution problem in urban settlement areas, such as the dissemination of renewable and clean energy resources (natural gas, thermal energy, etc.) in domestic heating and industrial processes, more frequent controls for the measurements for air quality in terms of spatial and time tables, improving the control strategies, developing plan decisions in consideration of air corridors, the dissemination of open and green areas, encouragement of public transportation and railway transportation type by local governments and realizing studies to minimize carbon emissions and to improve the air quality and controlling over facilities of industrial areas.

Improving the public health of urban settlement areas is no simple task for planners. It takes long-term policy strategies for sustaining change in urban ecosystems and environments. And it takes the necessary community and organizational infrastructure for carrying out those strategies. In short term, cities need comprehensive plans and health studies for sustaining its public health efforts, one that can help it manage internal and environmental urban challenges. Developing a plan or analyzing the health statistics are critical parts of the sustainability process. A plan or a statistical result can help obtaining input to decision-makers; define critical long- and short-term policy strategies.

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